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Article

Greenhouse Effect Expedition Porps: Shared Type Integrated Learning Media Based on Education for Sustainable Development in Climate Change Material

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ABSTRACT

In the era of increasingly urgent climate change, greenhouse effect expedition teaching aids have become an important component in developing sustainable education, especially for grade 7 students studying climate change material. This research aims to determine the development of greenhouse effect expedition teaching aids as an integrated learning medium based on shared education for sustainable development in class VII middle school climate change material. This research uses a 3D approach method (Define, Design, Develop). The define stage is the initial or defining stage which includes analysis of climate change material, learning objectives and design of teaching aids. The design stage includes analysis of the shape and design of the props resulting from the design stage, as well as how to use the tools. The develop stage is the development and evaluation stage through validation of science learning media experts from lecturers and teachers. The results of the media expert validation test obtained a score124 in the score interval, namely 82.7% in the very good category.Meanwhile, the results of the material expert validation test obtained a score69 in the score interval, namely 86.2% in the very good categoryIt is hoped that the research results will increase students' understanding of climate change material and support sustainable education at the junior high school level.

INTRODUCTION

Human activities, such as burning fossil fuels and deforestation, have increased the concentration of greenhouse gases in the atmosphere. One of the effects resulting from this phenomenon is the greenhouse effect. The Green House Effect is a phenomenon where the earth's temperature increases due to the capture of sunlight by greenhouse gases in the troposphere layer of the atmosphere. This phenomenon can cause global warming which has become a profound global issue. The increase in global average temperature since the mid-20th century has become a serious concern for various parties, and human activities, such as

the use of fossil fuels and reduction of vegetation, have been the main cause of increasing greenhouse gas concentrations, especially CO2 (Surtani, 2015) .

The impacts of global warming are real and serious, including melting polar ice caps, rising sea levels, climate change, and loss of flora and fauna. Overcoming this problem requires joint efforts, but awareness of the importance of maintaining environmental balance is a crucial first step. Thus, global warming can be reduced if we all unite in efforts to protect our environment. One of the causes of global warming that needs attention is exhaust gas emissions from motorized vehicles, and research into the mechanisms of the greenhouse effect as a result is becoming increasingly important (Surtani, 2015).

Sunlight that reaches the earth turns into heat and the earth becomes hot, but some of this heat is reflected back into space by gases in the atmosphere, creating a Greenhouse Effect. This effect is important because it maintains the earth's temperature so that it is habitable, because without the Greenhouse Effect, the earth's surface temperature would be very cold. Increasing the earth's temperature has an impact on extreme climate change, sea level rise, and negative impacts on agriculture, animals, and human health. The increase in CO2 is mainly caused by burning fossil fuels, while deforestation reduces nature's ability to absorb CO2. The amount of water vapor in the atmosphere may increase due to global warming and the strong Greenhouse Effect. Methane gas, which is released by agricultural activities and waste management, also contributes to the Green House Effect. Global warming also has an impact on more extreme weather, rising sea levels, disruption to agriculture, and threats to human health. Therefore, it is important to reduce greenhouse gas emissions and take action to overcome climate change in order to protect the Earth and life on it (Riza, 2019).

Education plays an important role in increasing public understanding and awareness, especially the younger generation, regarding the issue of climate change and how to overcome its impacts. One relevant approach is sustainable education (ESD - Education for Sustainable Development), which aims to increase individual and community understanding, awareness and action on sustainable issues, including climate change. ESD is a learning process that aims to support sustainability at various levels and types of education. ESD is described here as a tool that can be used to transfer knowledge, values, and skills related to sustainability issues, including the greenhouse effect and climate change. ESD highlights five main aspects of learning which include learning to know, learning to be, learning to live together, learning to do, and learning to change oneself and society. ESD also has important characteristics, such as increased awareness, integration of local and global dimensions, emphasis on responsibility, teaching adaptability, participation, and support for lifelong learning. ESD also plays a role in developing critical thinking, systems-based approaches, decision-making abilities, cross-disciplinary approaches, problem solutions, and paying attention to current needs without compromising the future. All of these elements create a strong basis for education about climate change, which can be realized through the development of greenhouse effect expedition teaching aids as a learning medium (Hariadi, 2016).

The learning media that can be used in this learning is using innovative shared type integrated science learning media which integrates the concept of the greenhouse effect in the disciplines of biology and physics. This teaching aid can increase students' understanding of the two scientific disciplines and their interrelationships in the context of the greenhouse effect. The advantage of the shared type is that the learning process is more meaningful, while the disadvantage is that it requires more preparation time from a teacher (Fogarty, 2009). This learning media will be a teaching tool that can help students understand the concept of the greenhouse effect in an interesting and informative way. So this research aims

to determine the development of greenhouse effect expedition teaching aids as a shared type of integrated learning media based on Education for Sustainable Development (ESD).

METHOD

The method used in developing innovation is a 4D model which is modified into 3D. The 3D development model consists of three stages, namely definition, design and development (Siratte, 2017). The definition stage begins with an analysis of initial and final findings to determine the problems and conditions needed to develop learning innovation. This analysis stage is carried out by identifying and determining the basic problems faced by students in learning science that require solutions through learning media development strategies. The next analysis is about student characteristics to determine student characteristics and needs as a reference in determining the learning media concept to be developed. After knowing the characteristics of the students, a concept analysis is carried out to identify, determine and compile the main material that will be developed in learning media. Next is a concept analysis which contains the concept and use of teaching aids to suit the material. The definition stage ends by determining more specific learning objectives to be appropriate based on the expected learning outcomes. At the design stage, the product framework is designed, while at the development stage, product validity is evaluated using the opinions of media experts and learning material experts from science lecturers and junior high school science teachers through validation test instruments which include several assessment components. The development stage is the stage for producing a development product and consists of two steps, namely expert appraisal accompanied by revision and developmental testing (Solehudin, 2019).

Calculation of validation test results can be done using the following formula:

Guidelines for calculating maximum validity scores:

$$Validalitas = \frac{\text{Skor Validasi}}{\text{Skor } maksimum} \text{ x } 100\%$$

Validation scores are obtained from validation results from media experts and material experts. The maximum score is obtained from the maximum overall validation score. Then, the average of the total score results is taken. Then to determine the benchmark categories as in Table 1.

Table 1. Percentage of Responses from Media Users

Percentage	Benchmarks
81% - 100%	Very good
61% - 80%	Good
41% - 60%	Pretty good
21% - 40%	Not good
0% - 20%	Very not good

Source: Arikunto (2007)

RESULTS AND DISCUSSION

Definition Phase (Definition/Analysis)

1. Start-finish analysis

   At the initial analysis stage, it was found that science learning for certain groups of students was known to be boring. This statement could be caused by many factors, one of which is the low motivation to learn science among students because the learning model seems monotonous. Susanti (2015) revealed that students' learning motivation influences their learning outcomes.

The solution that teachers can take is to apply a project-based learning model or teaching aids. The use of teaching aids aims to increase the effectiveness of learning by creating interesting, memorable learning and increasing student learning motivation.

This time the author took science material in the form of climate change. From the previous lesson, the teacher used teaching aids with the concept of comparing an environment that is still maintained and an environment affected by global warming. However, the author thinks that the teaching aids are too monotonous and cannot explain the causes of global warming. Therefore, the author innovates by developing existing teaching aids.

Apart from applying the concept of comparison between an environment that is still maintained and an environment affected by global warming, this teaching aid also provides reasons why global warming can occur. Namely by depicting the greenhouse effect, so the author hopes that with this students can find out the causes of global warming.

2. Analysis of student characteristics

   This analysis is used to adapt these teaching aids to students. Climate change material will be studied by junior high school students in class VII. Therefore, this tool was created to support the learning of class VII SMP students. The student characteristic that must be met is curiosity, even though it is relatively low. Because it is in accordance with the aim of the teaching aids, namely increasing learning motivation, so that it will go hand in hand with students' curiosity.

3. Analysis of concepts and content structure

   This analysis was carried out to develop the concept of teaching aids so that they are in accordance with the science material on climate change. Apart from that, this analysis aims to adapt to the learning objectives of class VII middle school students. These props are designed to be attractive so that students are interested when they first see the props and their curiosity arises.

4. Specification of learning objectives

   Based on the analysis of the concept and structure of the content, the objectives of learning with global warming science material teaching aids are:

   a) Students are able to understand the causes of climate change.
   b) Students are able to understand how the greenhouse effect influences climate change.
   c) Students are able to understand the impact of the greenhouse effect on climate change.

Design Phase

At this design stage, the materials to be used are selected, as well as the working mechanism of the props. The materials used in this prop include wooden boards, mirrors, flashlights and styrofoam as complementary miniatures. In this teaching aid, students will study global warming caused by the greenhouse effect with a comparative model. The work steps are as follows:

Comparison 1 (Environment)

a) The teacher sets up props with backgrounds and miniature living environments.
b) The teacher turns on the installed flashlight, so that the direction of the light is directed towards the mirror.
c) From the mirror, light will be reflected onto the plain board directly above, just like the sun's heat is reflected back into the atmosphere.

Comparison 2 (Damaged Environment)

a) The teacher sets up props with backgrounds and miniatures of damaged environments.
b) The teacher turns on the installed flashlight, so that the direction of the light is directed towards the mirror.

c) From this mirror, light will be reflected upwards, just like the sun's heat is reflected back into the atmosphere.
d) The part of the board above (atmosphere) has 2 sides, namely the plain side and the side with the mirror attached.
e) The board is turned over so that the light reflected from the mirror below will be reflected back down, just like the sun's heat which cannot reach the atmosphere is reflected back to the earth because of the greenhouse effect.

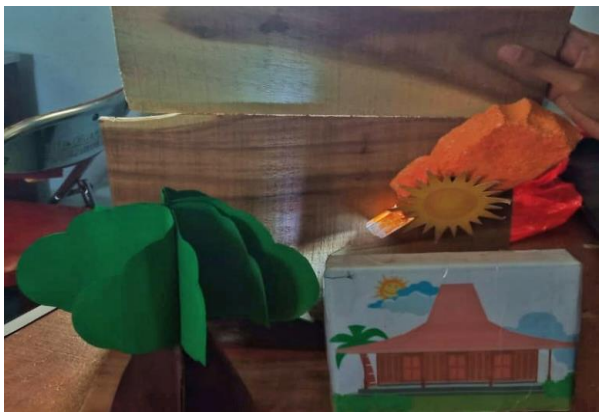

Figure 1. Image of a healthy environment (before validation)

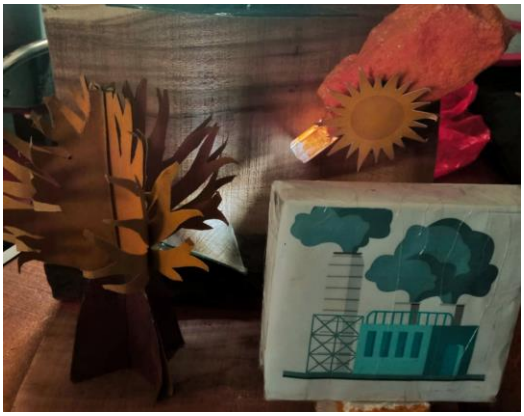

Figure 2. Image of damaged environment (after validation)

Develop Phase (Development and Evaluation)

At the development stage, validation tests were carried out on the greenhouse expedition props by four experts, including two learning media experts (IAIN Ponorogo lecturers) and two learning material experts (IAIN Ponorogo lecturers and science teachers from MTs Darul Huda Mayak). The instrument used for the media expert validation test contains components of effectiveness, convenience, suitability, completeness, communicative and interactive, and safety for students. Meanwhile, the instrument used for the material expert validation test contains components of suitability, completeness, convenience and clarity.

The results of the validation test analysis by experts in learning media for expedition teaching aids for home effects tools with shared and ESD-based types can be seen in table 2.

Table 2. Media expert validation test results

No.	Assessment criteria	Score		Total Validation Score	Total Maximum Score
		Media Expert 1	Media Expert 2		
1.	Effectiveness	9	8	17	20
2.	Convenience	19	14	33	40
3.	Suitability	18	16	34	40
4.	Completeness	8	7	15	20
5.	Communicative and interactive	10	7	17	20
6.	Security	5	3	8	10
Total				**124**	**150**

Based on table 2, it shows that the media expert validation test results with the average final validity value results are as follows:

$$Validalitas = \frac{\text{Skor Validasi}}{\text{Skor } maksimum} \text{ x 100 \% x 100 \% = 82.7 \%} = \frac{124}{150}$$

By obtaining a percentage of 82.7%, the learning media for greenhouse effect expedition teaching aids is included in the very good category, because the percentage is between 81%-100%.

Meanwhile, the results of the expert validation test analysis of learning materials for expedition props for greenhouse effect equipment with shared and ESD-based types can be seen in table 3.

Table 3. Material expert validation test results

No.	Assessment criteria	Score		Total Validation Score	Total Maximum Score
		Expert Material 1	Expert Material 2		
1.	Suitability	14	14	28	30
2.	Completeness	12	14	26	30
3.	Convenience	4	4	8	10
4.	Clarity	3	4	7	10
Total				**69**	**80**

Based on table 3, it shows that the material expert validation test results with the average final validity value results are as follows:

$$Validalitas = \frac{\text{Skor Validasi}}{\text{Skor } maksimum} \text{x 100 \% x 100 \% = 86.2 \%} = \frac{69}{80}$$

By obtaining a percentage of 86.2%, the learning media for greenhouse effect expedition teaching aids is included in the very good category, because the percentage is between 81%-100%.

Greenhouse Expedition as a Shared Type Integrated Science Learning Media

The Greenhouse Expedition is an innovative integrated science learning media in the form of teaching aids to demonstrate climate change material in the greenhouse effect section. The integration type of this teaching aid is the shared type. The shared type is an integrated learning type that combines two scientific disciplines. The characteristics of the shared type are overlapping, both in terms of concepts and skills (Fogarty, 2009).

The greenhouse effect expedition teaching aid is a form of learning media that integrates the concept of the greenhouse effect simultaneously in the disciplines of biology and physics. Judging from biology, with this media students can understand the impact of the greenhouse effect on ecosystems, as well as understand the process of climate change that affects organisms and the environment. Meanwhile, from physics, students can understand the concept of temperature and heat transfer from the greenhouse effect process.

The advantage of the shared type is that the learning process that takes place becomes more meaningful (Fogarty, 2009). In using the greenhouse effect expedition tool, where there is collaboration between biology and physics, students not only gain a deeper understanding of these two scientific disciplines, but students can also see the connection between the two. Collaboration between physics and biology through this media can create a more comprehensive understanding of the impact of the house effectglass on the ecosystem, thereby enabling students to connect theory with everyday life and making learning more relevant and significant.

Meanwhile, the weakness of the shared type is that it requires more preparation time than a teacher (Fogarty, 2009). Applying a greenhouse expedition tool that integrates physics and biology, teachers need to make careful preparations to create an effective learning experience. Includes material design, adapting to the curriculum and integrating concepts from two different scientific disciplines. Although the preparation required can be challenging, the results can be very rewarding. Students will gain a deep understanding of the relationship between physics and biology in the context of the greenhouse effect.

Greenhouse Expedition as a Learning Media Based on Sustainable Development Education

The Greenhouse Expedition is an innovative learning media in the form of teaching aids to demonstrate climate change material, sub-chapter on the causes of climate change, one of which is the greenhouse effect. This learning media was created based on Education for Sustainable Development (ESD). ESD or education for sustainable development is education whose understanding focuses on the natural and social environment. The goal of ESD is to build the capacity and commitment necessary to build sustainable societies, where individual and collective decision-making takes into account natural economic and ecological processes to improve the quality of life now and in the future. ESD is an educational program that is suitable for teaching students from an early age to reduce dependence on the natural and social environment and teaches students to be active and knowledgeable about nature and environmental issues. These environmental issues include climate change, ecosystems, biodiversity, availability of natural resources and livelihoods and excessive consumption (Prabawani, 2021).

The greenhouse effect expedition was prepared on an ESD basis which aims to raise students' awareness about the current issue of climate change. Through this teaching aid, students can learn about the process of the house effect, the impact of the greenhouse effect and its relationship to climate change. Thus, this teaching aid not only provides meaningful learning, but also provides a deep understanding of the importance of protecting the environment and responding to emergency environmental issues.

The use of ESD-based greenhouse effect teaching aids is an appropriate approach to equip students with the knowledge and skills needed to reduce dependence on nature and the environment. Especially in the context of the urgent issue of climate change. The application of this teaching aid provides an opportunity for students to understand important concepts in preserving natural resources, energy efficiency and mitigation efforts. Through this teaching aid, students can learn what actions humans must take so that they can contribute to environmental preservation and minimize the negative impacts of climate change, which is a global challenge and needs to be overcome together.

The use of ESD-based greenhouse expedition props has an important role in shaping students to become individuals who play an active role and are actively knowledgeable and responsive to nature and environmental issues, especially climate change issues. Through the learning gained from this teaching aid, students are taught to understand the complexity of ecosystems, the impact of human behavior on the environment, and what actions must be taken to influence climate change.

In addition, greenhouse expedition teaching aids are able to encourage students to be responsive to environmental issues by developing awareness of the importance of preserving natural resources, reducing greenhouse gas emissions and supporting sustainable initiatives. In this way, the greenhouse effect expedition demonstration tool becomes a forum for motivating students to be more concerned and responsible for the environment, as well as becoming active agents of change in preserving the earth and overcoming climate change.

Validity of the Greenhouse Effect Expedition Props

Based on the results of media expert validation tests and learning materials carried out by science lecturers and teachers, it shows that the average score for validation tests for learning media experts as a whole is 124 in the score interval, namely 82.7% in the very good category. Meanwhile, the average value of the validation test for learning material experts as a whole is 69 with a score interval of 86.2% in the very good category. This shows that the greenhouse effect expedition teaching aids meet the criteria for valid learning media and are

worth testing and revising according to suggestions. However, of course there is still input and suggestions from validators, including providing brief information or explanations about the components of the atmosphere, providing a background at the bottom, sides and top to make the appearance more attractive, using a toy laser as an illustration of the sun, and using materials other than a mirror for illustrating a place where light reflects. These suggestions and input can be taken into consideration to increase the effectiveness of using learning media teaching aids.

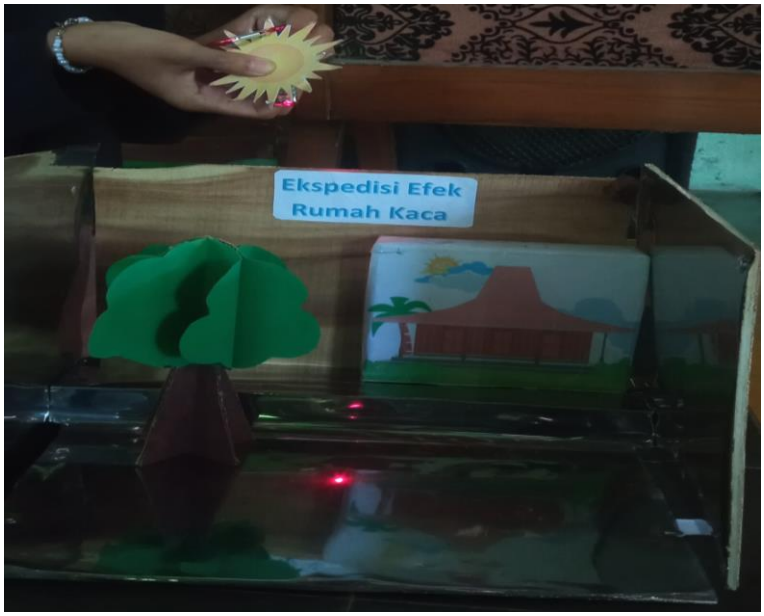

Figure 3. Image of a healthy environment (before validation)

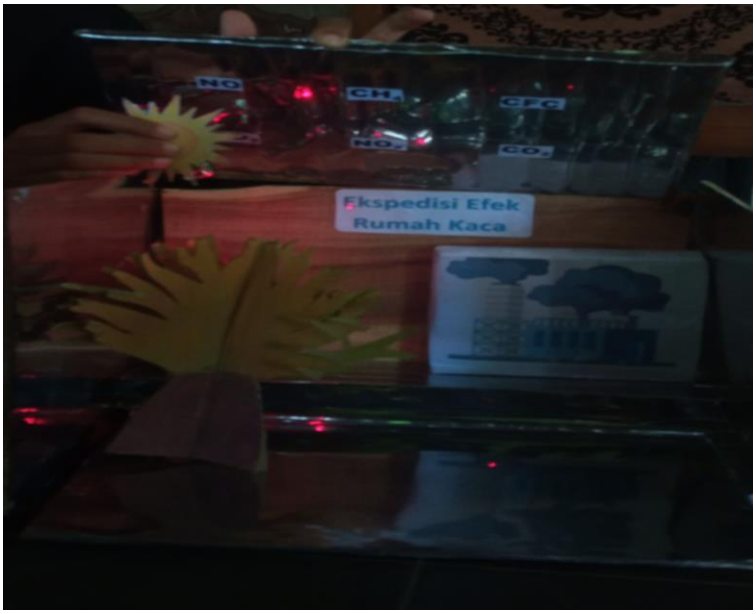

Figure 4. Image of damaged environment (after validation)

CONCLUSION

Based on this research, it can be concluded that the development of teaching aids Greenhouse effect expedition with an integrated shared and ESD-based type, aims to demonstrate to students about the process, causes and impacts on human life. This shared type of teaching aid overlaps the concept of the greenhouse effect which integrates two

concepts, namely the impact of the greenhouse effect on the ecosystem and the concept of heat transfer. The concept of this teaching aid is a comparison model between a beautiful environment and a polluted environment. The results of the validation from media experts and material experts are worth testing and revised according to suggestions, with the average value of validation tests from learning media experts overall it is 124 in the score interval, namely 82.7% in the very good category. Meanwhile, the average value of the validation test for learning material experts as a whole is 69 in the score interval, namely 86.2% in the very good category.

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